# Reversible Aggravation of Neurological Deficits after Steroid Medication in Patients with Venous Congestive Myelopathy Caused by Spinal Arteriovenous Malformation

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**Key words:** steroids, myelopathy

***Summary***

*Steroids are empirically used to medicate patients with myelopathy of unknown etiology. We report the reversible aggravation of neurological status after steroid administration in a patient with venous congestive myelopathy (VCM). We retrospectively evaluated 36 patients with angiographically confirmed spinal arteriovenous malformation (SAVM) from a prospectively collected neurointerventional database. We evaluated steroid medication and neurological aggravation using Aminoff grading and analyzed using Fisher's exact test whether steroid medication is related to neurological aggravation and spinal cord edema as demonstrated on MR T2-WI. Among 26 patients who had been treated with steroids, ten had aggravated neurological deficits. The aggravation in these ten patients was related to the steroid medication (P = 0.039 in all patients) and only marginally to VCM with spinal cord edema as seen on T2-WI (P = 0.074). Aggravation caused by using a high intravenous dose (250-1000 mg) of methylprednisolone or dexamethasone at 8-20 mg/day slowly decreased after stopping the steroid medication. Steroids were reversibly detrimental in patients with VCM caused by SAVM. A history of neurological aggravation after the use of steroids may suggest the diagnosis of SAVM associated with VCM.*

## Introduction

Venous congestive myelopathy (VCM) often results from impaired venous outflow secondary to a spinal arteriovenous malformation (SAVM) [1]. Foix-Alajouanine syndrome, also known as subacute necrotizing myelopathy or angiodysgenetic necrotizing myelopathy, is the term formerly used to describe this progressive myelopathy. One of the causes is known to be spinal dural arteriovenous fistula (SDAVF) [2].

As steroid medication is used for spinal cord trauma, transverse myelitis and cord tumor, glucocorticoids are empirically used to relieve spinal cord edema in patients with unknown etiology of their subacute necrotizing myelopathy. However, the exact mechanism or effect have not been clearly elucidated.

Our clinical experience with the rapid aggravation of spinal cord symptoms in patients with SAVM and their slow recovery after discontinuation of the steroid administration, prompted us to retrospectively review a cohort of 36 SAVM patients found in our institution's database. We thus report the effect of empirical administration of glucocorticoids in patients with VCM or with undiagnosed myelopathy associated with SAVM.

We also discuss the mechanism of the reversible aggravation.

## Methods

As we had two patients who revealed sudden aggravation of their neurological deficits after intravenous steroid injection, we retrospectively reviewed the medical records of 36 patients with SAVM who had been prospectively listed in our institution's database over the past 18 years, i.e. 20 spinal dural arteriovenous fistulas, nine spinal pial AVFs (SPAVF), five osseous epidual AVMs, and two metameric AVMs.

We defined spinal DAVF as when there is a radicular arterial feeder draining into a radicular vein and thus leading to perimedullary venous congestion, spinal pial AVF when the feeders converge to the cord surface with engorged perimedullary venous drainage, and as osseous epidural AVM when the AVM involves the bone recruiting the bony feeders and revealing a corresponding bony lesion seen on a CT scan[3-5]. In osseous epidural AVM, we identified retrograde drainage of the shunted flow in-

Table 1 **Summary of 36 Patients with Spinal Arteriovenous Malformation.**

| Steroids | Status after Steroids | Edema on T2WI | Enhanced on T1WI | Diagnosis (AVM/AVF) | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | | | Dural | Pial | Oss | Meta | |
| Used | Improved | 3 | 2 | 2 (2) | 1 | 1 (1) | 0 | 4 |
| | Not changed | 8 | 7 | 5 (4) | 3 (2) | 2 (1) | 2 (1) | 12 |
| | Aggravated | 10 | 6 | 8 (8) | 2 (2) | 0 | 0 | 10 |
| Not used | Not changed | 6 | 3 | 5 (4) | 3 (2) | 2 | 0 | 10 |
| Total | 27 | 18 | | 20 (18) | 9 (6) | 5 (2) | 2 (1) | 36 |

*AVM, arteriovenous malformation; AVF, arteriovenous fistula; Oss, Osseous; Meta, Metameric.*
*Parenthesis = No. of patients who revealed edema on T2WI*

Table 2 **Summary of ten Patients with Aggravated Symptoms after Steroid Medication.**

| Age/ sex | Dx | Edema on T2-WI | Enhance-ment on T1-WI | Steroids used | Initial deficits | | Change of deficits after steroids | | Procedure | Lesion cure | Final outcome | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Motor (R/L) | Mic | Motor/ Sensory | Mic | | | Gait | Mic |
| 54/M | SDAVF | + | + | MPD | IV/IV | 1 | +/- | - | ND | Not cured | 3 | 1 |
| 42/M | SDAVF | + | + | Dexa | III/IV | 1 | +/- | - | Embo | Partial | 2 | 1 |
| 45/M | SDAVF | + | - | MPD | IV/V | 1 | +/+ | + | Embo | Complete | 2 | 1 |
| 61/M | SDAVF | + | - | MPD | V/V | 3 | +/- | - | Embo | Partial | 1 | 2 |
| 47/M | SDAVF | + | + | Dexa | V/V | 2 | -/+ | - | OP | Complete | 1 | 2 |
| 56/M | SDAVF | + | + | MPD | IV/IV | 1 | +/- | - | Embo | Complete | 1 | 1 |
| 57/M | SDAVF | + | + | Dexa | I/I | 3 | +/- | - | Embo (post) | Complete | 3 | 3 |
| 34/M | SDAVF | + | - | MPD | III~IV/ III~IV | 2 | +/+ | - | OP | Complete | 4 | ND |
| 17/M | SPAVF | + | + | MPD | II/II | 1 | -/- | + | Embo (post) | Partial | 5 | 2 |
| 29/M | SPAVF | + | - | Dexa | IV/V | 1 | +/- | - | Embo | Partial | 3 | 1 |

*Dx, diagnosis; SDAVF & SPAVF, spinal dural & pial arteriovenous fistula; +/-, presence/absence of change; MPD, methyprednisolone; Dexa, dexamethasone; Motor, motor grade of both lower extremities; ND, not done; Embo, embolization; OP, surgical operation; (post), steroids were used post-procedurally; Mic, micturition. Final outcome grading including micturition was based on Aminoff MJ et Al[3] (gait 0 = normal, 5 = confined to wheelchair, Mic 0 = normal, 3 = total incontinence)*

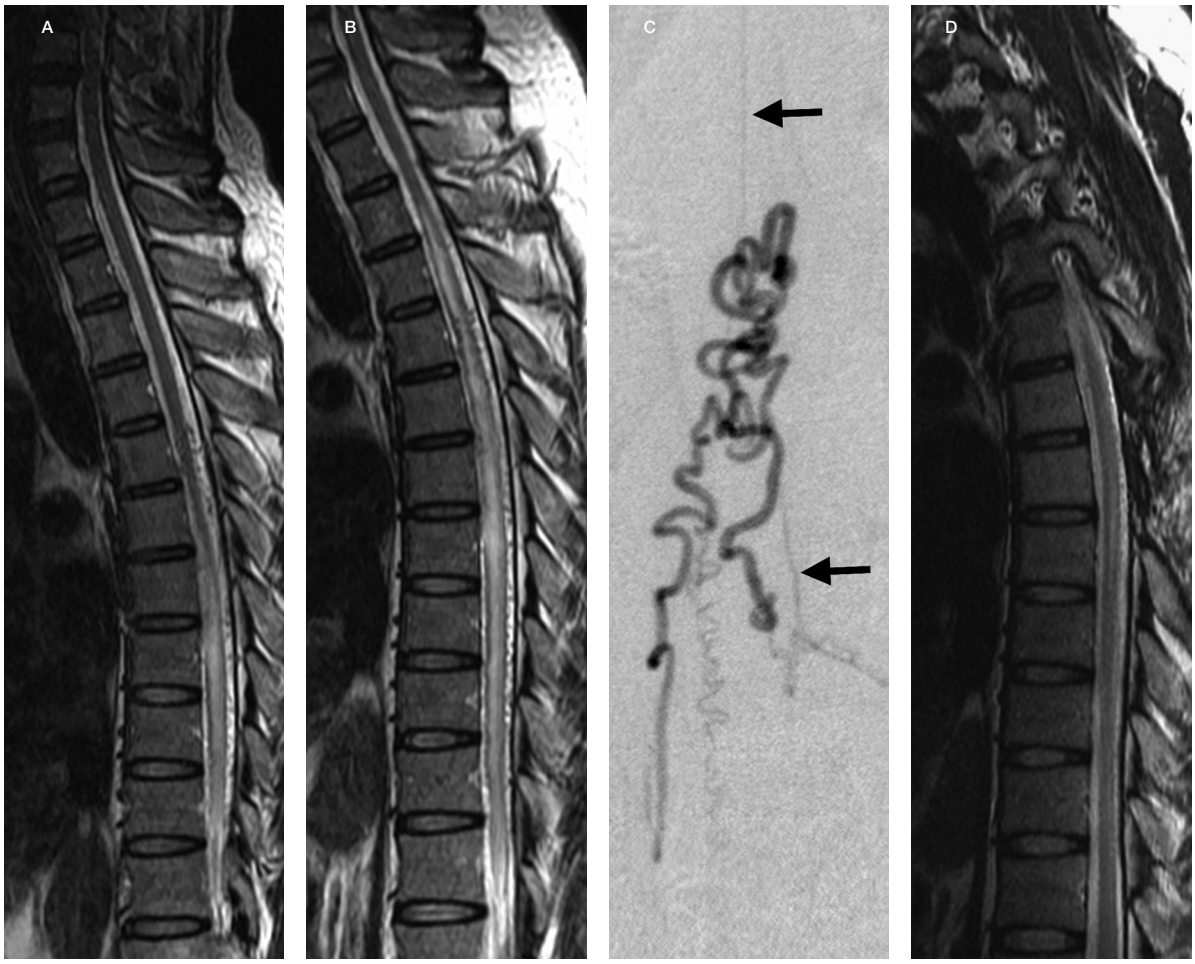


*Figure 1* A 34-year-old man presented with progressive lower leg weakness and urinary incontinence for three months. A) Sagittal T2-weighted MR image shows a swollen spinal cord below the T5 level with high signal intensities. B) Note the increased extent of the high signal intensities of the spinal cord up to the T2 level corresponding to aggravation of the neurological deficit following steroid administration. C) Selective spinal angiogram of the left T6 radicular artery reveals a single feeder of the spinal dural arteriovenous fistula. The anterior spinal artery (arrows) arises at the same level as the feeder, which precluded a neurointerventional approach. D) Decreased high signal intensities and spinal cord swelling are noted after surgery with improvement of the neurological deficit seen at the nine month follow-up.

to the radicular vein which attributed to congestive venous myelopathy in two of five patients as progressive medullary symptoms can also be noted in relation to bone erosion or to large venous pouches. We defined metameric AVM as when a vascular malformation involves the spinal cord, bony structures, paraspinal musculature, subcutaneous tissue, and/or skin in the same segment [3].

This study was approved by our institutional review board. A recent patient with SDAVF was added from the Inha University Hospital (Pyun HW) because the MRI features in the aggravated and improved states after steroid medication were well demonstrated and had been excluded in the statistical analysis. Our study patients' ages ranged from nine to 76 years (mean 43) and there was a male/female ratio of M:F = 26:10. The levels of the lesions were cervical (n = 6), thoracic (n = 21) and lumbosacral (n = 9) areas. Spinal MRI revealed spinal cord edema of high signal intensity on T2-WI (n = 27) and a cord enhancement on T1-WI (n = 18).

We retrospectively reviewed the medical records and converted the description in the medical records to the Aminoff grade to compare the change in the patient's neurological status. If there was no or only an incomplete description in the medical records, we regarded

the patient as having no change. We regarded any change in neurological status within at least three days after steroid injection as being related to the steroid injection. Symptom onset was within one month (n = 8), two to six months (n = 11), seven-12 months (n = 8), and more than one year (n = 9). Steroid medication had been used in 26 of the 36 study patients (72%). Ten of the 26 patients (38%) experienced aggravation of their neurological deficit after receiving steroid medication (Figure 1). Five of ten patients were medicated before the diagnosis of SAVM. We evaluated the degrees of aggravation based on the Aminoff grading system6 and reversibility of the deficit, steroid used, and the dose given. The relationship between steroid administration and aggravation of the neurological deficit or spinal cord edema, as seen on T2-WI, was analyzed using the 2 or Fisher's exact test.

## Results

Table 1 summarizes the information on the 36 patients with SAVM. Among 26 of these patients who had been treated using steroids, ten had aggravated neurological deficits. The aggravation in these ten patients was related to administration of steroid medication (P = 0.039) and VCM revealing spinal cord edema on T2-WI (P = 0.074). Aggravation in eight of 15 patients with SDAVF was caused by a statistically marginal relationship with the steroid injection (P = 0.055) probably due to our small patient number. The patients' aggravated symptoms improved slowly after stopping the steroid medication. Among these ten patients, two underwent lumbar puncture which was unrelated to the symptom aggravation as there was no change in the neurological deficit after the puncture which had been done five and nine days previously, respectively. Steroids were administered using intravenous methylprednisolone 250 - 1000 mg or 8 - 20 mg dexamethasone per day for one to three days. Each patient's final outcome was related to obliteration of the fistula or AVM by either appropriate embolization or surgery (Table 2).

## Discussion

Although steroids have been used in patients with progressive diffuse myelopathy caused by SAVM, symptom aggravation after steroid medication was observed in at least 38% of our patients who had been given steroids. Because of the fluctuating clinical nature of SDAVF, physicians who order steroids may erroneously regard such an aggravation effect of a steroid as a changing pattern in the patient's neurological deficit. Therefore, our report provides evidence that close observation is mandatory when steroids are given and their discontinuation is indicated as soon as aggravation of a neurological deficit appears in patients with known diffuse myelopathy. In addition, a history of such aggravation can further suggest VCM of SAVM which requires a thorough spinal angiographic study.

Two kinds of steroids were administered intravenously to our patients who experienced aggravation, i.e. methylprednisolone 250 - 1000 mg or 8 - 20 mg dexamethasone per day for one to three days. The difference in the two steroids is their anti-inflammatory potency and duration of action. Dexamethasone is approximately four to five times more potent and has almost twice the biological half-life of methylprednisolone.

Aggravating factors, such as exercise, in patients with VCM, have been known to be associated with decreased perfusion pressure between the spinal artery and vein, caused by increased venous hypertension [1]. However, it is uncertain that aggravation after steroid injection, as noted in patients with SDAVF (8/10) as well as in those with SPAVF (2/10), was related to decreased perfusion pressure in our study [7-9].

Although steroids can decrease vasogenic edema that develops with cerebral venous thrombosis, steroids have not been useful and have even been detrimental in patients with cerebral venous thrombosis as they promote thrombosis or inhibit thrombolysis [10]. Based on the reversibility of steroid-induced deterioration in VCM, we also postulate that steroids may reduce retrograde perfusion from the venous side-side in patients with long-standing venous hypertension of the spinal cord, probably because they decrease the previously increased capillary permeability of the blood-spinal cord barrier. However, prospective studies or animal experiments may be necessary to determine the exact cause and possible mechanism of steroid therapy in VCM. Histories of symptom aggravations after steroid medication in patients with progressive myelopathy of unknown etiology may suggest SAVM. Therefore,

an MR angiographic technique capable of localizing a spinal dural AVF with its small feeding artery and draining veins or a selective spinal angiogram must be used to locate the undetected fistula [11].

## Conclusions

Steroids can reversibly aggravate neurological symptoms in patients with VCM and should be used carefully and closely monitored after administration. As such a history of aggravation may suggest a hidden spinal AVM associated with VCM, a thorough angiographic evaluation is necessary to detect a curable spinal vascular malformation.

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